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(54) C.I. engine fuel injector

(57) A fuel injector has two stage lift of a valve member 18 with a conical tip 32 which is spring biased into engagement with a seating 30. When the tip is lifted a small distance from the seating fuel flows at a restricted rate through the orifice 16A and by forming grooves 35 or 34 or flats in the tip or seating the zone of maximum restriction to the flow of fuel is moved away from the minimum diameter portion of the seating.

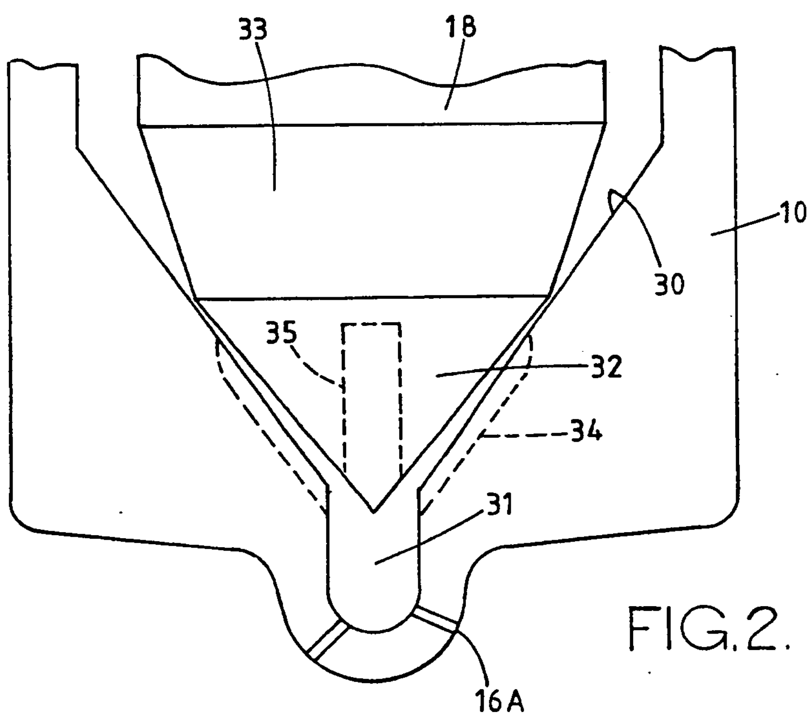

FIG.2.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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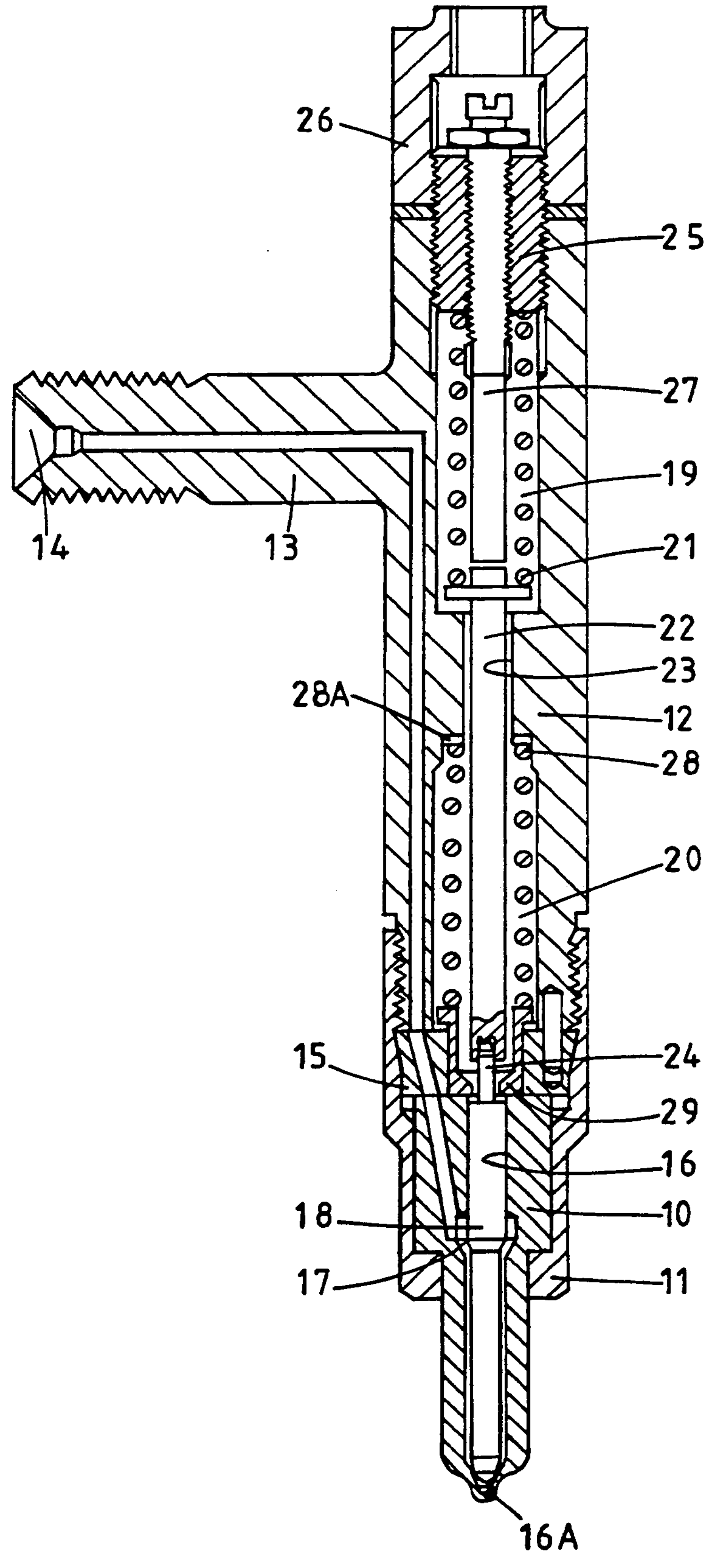

FIG.1.

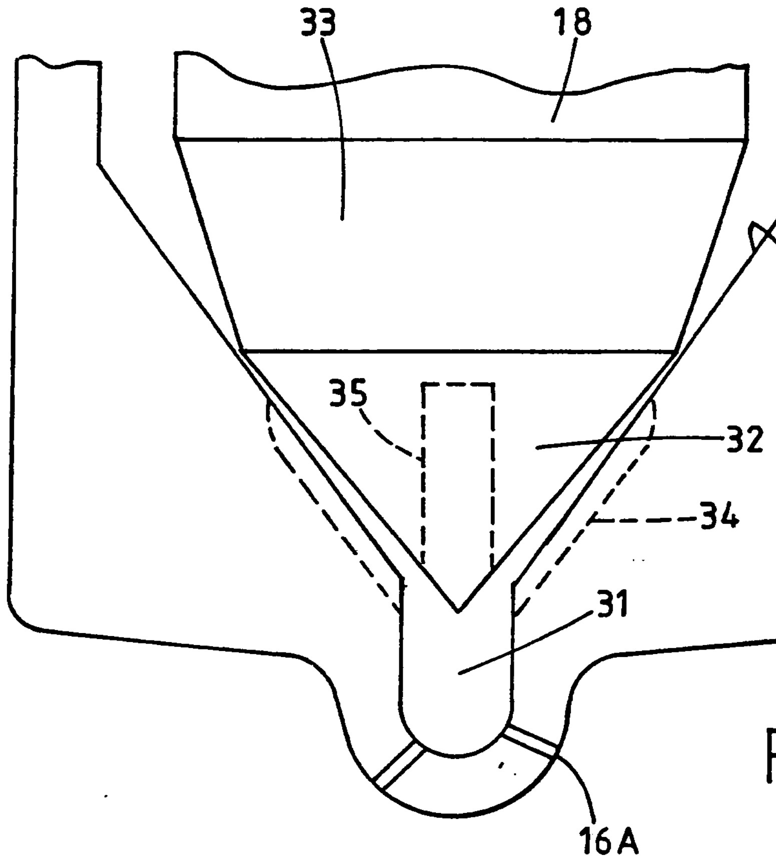

FIG.2.

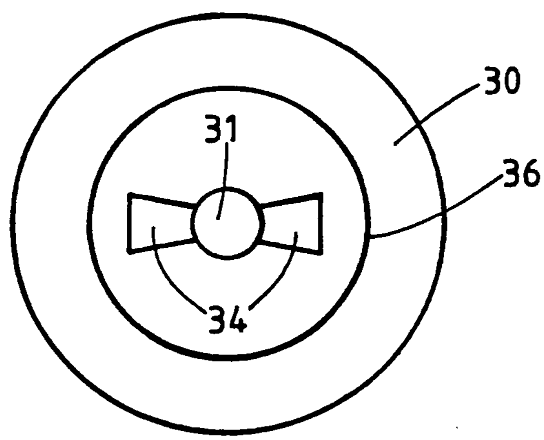

FIG.3.

FUEL INJECTION NOZZLES

This invention relates to fuel injection nozzles for supplying fuel to a compression ignition engine the nozzle comprising a nozzle body in which is formed a blind bore, a frusto conical seating defined at the blind end of the bore, the seating surrounding the entrance to a sac volume which forms a continuation of the bore, an outlet orifice extending from the sac volume, a valve member slidable in the bore, the valve member having a tip defining a conical profile for co-operation with the seating, the conical profile of the valve member and the seating engaging at a so-called seat line to prevent flow of fuel from a fuel inlet through the outlet orifice, the seat line of the valve member being at the wider portion of the tip and the seat line of the seating being towards the larger diameter end thereof, spring means biasing the valve member into contact with the seating and means for limiting the initial lift of the valve member from the seating to provide a restricted flow of fuel through said outlet orifice.

Such nozzles are well known in the art and provide an initial restricted rate of fuel flow to the associated engine to enhance the operation of the engine. The restriction to the flow of fuel is formed by the annular gap between the valve member and the seating and because of the conical nature of the seating and the valve member, the zone of maximum restriction to fuel flow occurs in the region of the minimum diameter of the seating.

In the use of a fuel injection nozzle the tip of the valve member and the surface which defines the sac volume become coated with deposits of coke and lacquer from the fuel. In a conventional nozzle in which the valve member is lifted its maximum extent from the

seating without the initial limited lift, the deposit will have little effect on the flow of fuel until the deposit becomes very thick. In a nozzle of the kind specified however in which the initial lift is limited even a small thickness of deposit can seriously reduce the initial rate of fuel flow. It is found that the thickness of the deposit on the seating and the valve member diminishes as the distance from the sac volume increases and the object of the present invention is to provide a fuel injection nozzle of the kind specified in which the zone of maximum restriction to flow of fuel in the initial stage of lift of the valve member is further away from the entrance to the sac volume.

According to the invention in a fuel injection nozzle of the kind specified the valve member or the seating is provided with a groove or grooves extending to adjacent the seat line thereby to move the zone of maximum restriction to the flow of fuel away from the minimum diameter portion of the seating.

An example of a fuel injection nozzle in accordance with the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a sectional side elevation of the nozzle,

Figure 2 is a view to an enlarged scale of part of the nozzle seen in Figure 1 and

Figure 3 is a plan view to a slightly reduced scale of part of the nozzle seen in Figure 2.

Referring firstly to Figure 1 of the drawings, the nozzle comprises a nozzle body 10 which is secured in known manner by means of a cap nut 11, to one end of a generally cylindrical nozzle holder 12 which has a transverse projection 13 defining a fuel inlet 14. Interposed between the nozzle body and the holder is a spacer member 15.

Formed in the nozzle body 10 is a blind bore 16 which at its end remote from the holder defines a seating which will be further described with reference to Figure 2, and downstream of which is a sac volume from which extends an outlet orifice 16A. Intermediate its ends the bore defines an enlargement 17 which is connected by communicating passages in the body, the spacer member and the holder to the fuel inlet 14. Slidable in the bore is a valve member 18 the portion of which extending between the enlargement 17 and the seating is of reduced diameter. The valve member is shaped for co-operation with the seating in a manner to be described and the step defined on the surface of the valve member forms an area against which fuel under pressure supplied to the inlet 14 can act to generate a force to lift the valve member away from the seating thereby to allow fuel flow through the orifice 16A.

Formed in the holder are a pair of chambers 19, 20 the chambers being located in spaced end to end relationship. The first chamber accommodates a spring 21 one end of which bears against an abutment formed on the end of a pushrod 22 extending through a drilling 23 connecting the two chambers and then through the chamber 20 to locate on a projection 24 formed as an extension of the valve member. The other end of the spring 21 engages an adjustable plug which can be locked relative to the

holder by means of a locking cap 26. The axial setting of the plug determines the so-called nozzle opening pressure. Adjustably mounted in the plug is a stop rod 27 which is engageable by the push rod to determine the maximum movement of the valve member away form the seating.

Located within the chamber 20 is a further coiled compression spring 28 which at one end bears against the step defined between the chamber 20 and the drilling 23. At its other end the spring bears against a tubular abutment 29 which is slidable within a central opening formed in the spacer member 15. The abutment 29 is larger in diameter than the valve member and can engage the valve body 10. The inner diameter of the spacer member at its end adjacent the body 10 is smaller than that of the valve member and it will be seen that there is a small gap between the end of the valve member and the abutment. In operation, when fuel under pressure is supplied to the inlet 14 a force is developed on the valve member and when the force is sufficient to overcome the force exerted by the spring 21, the valve member lifts from the seating, the extent of lift being determined by the abutment of the valve member 18 with the spring abutment 29. The initial clearance between the abutment and the valve member is therefore taken up and fuel is supplied to the associated engine at a restricted rate. As the fuel pressure at the inlet continues to increase there will be an increase in the force exerted upon the valve member and further movement of the valve member will occur when the force is sufficient to overcome the combined actions of the springs 21 and 28. The extent of further movement of the valve member is limited by the abutment of the pushrod 22 with the stop rod 27. As previously described the

setting of the plug 25 determines the fuel pressure which is required to effect the initial movement of the valve member away from its seating and the force exerted by the spring 28 which determines the fuel pressure required to allow the valve member to lift its maximum extent, can be adjusted by means of a shim 28A interposed between the end of the spring 28 and the shoulder defined between the chamber 20 and the drilling 23.

Turning now to Figure 2 this shows to a substantially enlarged scale, the shape of the end of the valve member and the seating.

Referring to Figure 2 the frusto conical seating is seen at 30 leading into the sac volume 31 from which extends the outlet orifice or orifices 16A. The valve member 18 has a nozzle tip 32 of conical form the cone angle of the tip being slightly larger than that of the seating. Between the tip 32 and the main portion of the valve member is a frusto conical section 33 having a cone angle which is smaller than that of the tip and the seating. In the closed position of the valve member the valve member and seating contact at the so-called seat line which in the case of the valve member is the junction of the tip 32 and the section 33 and so far as the seating is concerned the seat line lies well away from the sac volume 31. When as described, the valve member moves through the initial stage of lift, fuel can flow between the tip and the seating and the main restriction to the flow of fuel occurs in the annular zone defined between the tip and the seating adjacent the sac volume 31. It will be understood therefore that deposits of coke and lacquer which form on the surface of the sac volume and the portion of the seating and nozzle tip adjacent the entrance to the sac volume can

seating and nozzle tip adjacent the sac volume can seriously influence the degree of restriction offered to the flow of fuel. In order to move the zone of restriction away from the sac volume it is proposed to form in the seating or in the nozzle tip, a series of grooves. In Figure 2 the grooves which are formed in the seating are indicated at 34 and the grooves formed in the tip are indicated at 35. In each case the grooves extend away from the sac volume to adjacent the seat line and the effect of the grooves is to move the zone of restriction to flow of fuel in the initial lifting phase, towards the seat line and since the deposit of coke and liquor diminishes as the distance from the sac volume increases, a more consistent performance of the nozzle is obtained.

Figure 3 is a plan view of the seating 30 with the so-called seat line being illustrated at 36.

The grooves 35 may in fact be formed simply as flats on the nozzle tip and the grooves 34 may be stamped or eroded while the nozzle body is in the "soft" state prior to hardening.

It will be understood that the type of nozzle shown in Figure 1 is by way of example only and the invention is equally applicable to other constructions of nozzle in which the initial lift of the valve member away from the seating is limited to provide a restriction to the flow of fuel.

CLAIMS

1. A fuel injection nozzle for supplying fuel to a compression ignition engine comprising a nozzle body in which is formed a blind bore, a frusto conical seating defined at the blind end of the bore, the seating surrounding the entrance to a sac volume which forms a continuation of the bore, an outlet orifice extending from the sac volume, a valve member slidable in the bore, the valve member having a tip defining a conical profile for co-operation with the seating, the conical profile of the valve member and the seating engaging at a so-called seat line to prevent flow of fuel from a fuel inlet through the outlet orifice, the seat line of the valve member being at the wider portion of the tip and the seat line of the seating being towards the larger diameter end thereof, spring means biasing the valve member into contact with the seating, means for limiting the initial lift of the valve member from the seating to provide a restricted flow of fuel through said outlet orifice, and the valve member or the seating being provided with a groove or grooves extending to adjacent the respective seat line thereby to move the zone of maximum restriction to the flow of fuel away from the minimum diameter portion of the seating.

2. A nozzle according to Claim 1 in which the groove or grooves on the valve member is/are defined by a flat or flats on the conical profile of the tip.

3. A nozzle according to Claim 1 in which the groove or grooves on the seating are formed prior to hardening the nozzle body.

4. A fuel injection nozzle for supplying fuel to a compression ignition engine comprising the combination and arrangement of parts substantially as hereinbefore described with reference to the accompanying drawings.

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